GUALALA RIVER

APPENDIX 6: HYDROLOGY

Table of Contents

I. GENERAL BASIN DESCRIPTION

The Gualala River drains 298 square miles along the coast of southern Mendocino and northern Sonoma Counties. The river enters the Pacific Ocean near the town of Gualala, 114 miles north of San Francisco, and 17 miles south of Point Arena. The Gualala River watershed is elongated running over 32 miles long north–south, with an average width of 14 miles. A general location map is shown in Figure 2 of the synthesis report. The North and South Fork stream channels follow very near, if not directly on top of, the San Andreas Fault Zone. A relatively straight and continuous ridgeline separates the Gualala River from the ocean. The river crosses the ridge in a saddle and flows northward to the ocean at the town of Gualala. Elevations vary from sea level to 2,602 ft. at Gube Mountain.

The climate is influenced by fog near the coast with seasonal temperatures ranging between 40 and 60 degrees F, but the interior basin can vary during the year from below freezing to over 90 degrees F. Rainfall is also highly seasonal with approximately 90 percent falling between October and April. Mean annual rainfall amounts are lowest near the lower elevations along the coastline at about 33 inches and increase eastward to the eastern edge of the upper watershed to a maximum of about 63 inches.

The Gualala River watershed has a long history of land use and fire, punctuated by floods. Since snow accumulation is minimal, a rainfall/runoff hydrology predominates in the Gualala River watershed. With steep slopes and high rainfall amounts, detention time and time of concentration of rainfall are reduced. Alterations of the landscape can likely change the hydrologic curves, flood frequencies and peaks within the subwatersheds of the Gualala River watershed.

The main stem of the Gualala River flows from the confluence of the South Fork and North Fork to the Pacific Ocean. This reach is greatly influenced by seasonal closures of the river mouth, which typically occur in early summer and last until the first heavy rains of October or November, although it may also close briefly during the winter months (CDFG 1968 and EIP 1994). Aggradation of the streambed in the lower portions of the major tributaries has probably reduced surface water flow to the estuary during periods of low precipitation.

DWR's Statewide Planning Program delineates the Gualala watershed within the North Coast Hydrologic Region (HR), the Coastal (#03) Planning Subarea (PSA), and the Gualala (#19) Detailed Analysis Unit (DAU). The USGS delineates the Gaulala watershed within Hydrologic Unit #18010109.

The Gualala River assessment team has divided the watershed into five principal watersheds for assessment purposes. These divisions are considered "sub planning watersheds" under the CalWater 2.2 Planning Watershed designation: Wheatfield Fork (37% of drainage), South Fork (21%), North Fork (16%), Buckeye Creek (14%), and Rockpile Creek (12%).

Only one stream gauge, "South Fork Gualala River near Annapolis", USGS gauge #11467500, operated for a significant period (October 1950 – September 1971 and June 1991 – June 1994). The gauge was located below the confluence with the Wheatfield Fork and measured the runoff from 161 or 54% of the total 298 square mile Gualala River watershed.

II. PRECIPITATION

Precipitation in the Gualala Watershed is highly seasonal, with approximately 90 percent falling between October and April. A very small portion of the precipitation may fall as snow in the upper reaches of the watershed. However, ridgeline elevations are less than 2,600 feet, and snowfall accumulations are very thin. Therefore, snowmelt events or rain-on-snow events are probably not hydrologically significant.

Seven precipitation gauges are or were located within the Gualala watershed with three gauges having a period of record exceeding twenty years. Twelve gauges are or were located within five miles of the watershed boundaries; four gauges have a period of record exceeding forty years. Twelve additional gauges are or were located within five to ten miles of the watershed boundaries; four gauges have a period of record exceeding forty years. Table II-1 contains the gauge identifiers, location, period of record, annual, and maximum daily precipitation for twelve gauges with long-term periods of record within or near the Gualala watershed. Chart II-1 graphically illustrates the period of record for the gauges. Figure II-1 provides a location map for the gauges located within the basin. An isohyetal map developed by PRIZM indicates that mean annual rainfall amounts are lowest near the coastline at 33 inches and increase eastward to the eastern edge of the watershed to a maximum of 63 inches. Highest rainfall amounts occur along the drainage divide in the southeastern region.

Two long-term precipitation stations still operating are located near the watershed at lower elevations. The Fort Ross gauge is located in the town of Fort Ross along the coast near the southern portion of the watershed, and has the longest period of record (1872 - present). It lies approximately 2 miles outside of the watershed boundary. Chart II-2 shows the annual precipitation at Fort Ross along with the cumulative departure from the mean for Water Years 1876 - 2000. The mean for the 128-year record is 43.27 inches. The wettest year was 1878 when 94.44 inches fell. The driest year was 1977 when 16.01 inches fell.

The Cloverdale gauge is located in the town of Cloverdale northeast of the central eastern portion of the watershed, approximately eleven miles outside of the watershed boundary at elevation 315 feet. Chart II-3 shows the annual precipitation at Cloverdale along with the cumulative departure from the mean for water years 1903 - 2000. The mean for the 101-year record (1894 - 1896 and 1903 - 2000) is 40.89 inches. The wettest year was 1983 when 79.26 inches fell. The driest year was 1924 when 13.54 inches fell.

Table II-1: Existing and discontinued long-term precipitation gauges located within or near the Gualala watershed.

EXISTING AND DISCONTINUED LONG-TERM PRECIPITATION GAUGES LOCATED WITHIN OR NEAR THE GUALALA RIVER WATERSHED

Station Name	Hedge-path Ranch 1/	Stewarts Point 2 NE 1/	Seaview 1/	Fort Ross	Gualala	Sail Rock Ranch	Yorkville	Cazadero	Cloverdale	Guerne-ville Mowry	Venado	Cloverdale 3 SSE
Station #	F 80	F80	F80	F80	F80	F80	F80	F90	F90	F90	F90	F90
	3889 50	8540 02	8542 60	3161 00	3679 00	7639 50	9851 00	1602 00	1837 00	3684 00	9273 00	1838 00
GAUGE LOCATION												
County	Mendocino	Sonoma	Sonoma	Sonoma	Mendocino	Mendocino	Sonoma	Sonoma	Mendocino	Sonoma	Sonoma	Sonoma
Longitude	122.294	123.367	123.208	123.250	123.533	123.583	123.313	123.292	123.017	123.000	123.017	122.983
Latitude	38.606	38.663	38.525	38.517	38.750	38.883	38.905	38.530	38.817	38.500	38.617	38.750
Elevation	920	860	1500	116	1000	100	1120	1040	315	55	1260	320
PERIOD OF RECORD												
Begin	1959	1959	1941	1872	1942	1911	1941	1943	1894	1925	1941	1948
End	present	1982	1961	present	present 2/	1998 3/	present 4/	present 5/	present 6/	present	present 7/	present 8/
ANNUAL PRECIPITATION												
Average	57.51	47.97	64.53	43.27	52.91	50.32	48.78	72.23	40.89	46.71	59.24	44.83
Maximum	100.78	85.23	106.65	94.44	83.42	93.94	94.70	123.24	79.26	94.54	113.35	79.16
Year	1998	1974	1958	1878	1958	1974	1941	1958	1983	1998	1941	1983
Minimum	20.62	21.13	42.17	16.01	34.87	23.69	20.30	44.02	13.54	17.33	33.06	18.38
Year	1977	1977	1947	1977	1947	1977	1977	1964	1924	1977	1991	1977
24-HOUR MAXIMUM PRECIPITATION												
Average	5.14	3.94	4.72	3.65	3.85	4.13	3.93	6.09	3.43	4.14	5.17	3.84
Maximum	8.22	6.13	8.58	10.00	7.31	8.07	7.05	10.75	8.37	12.40	10.32	8.37
Year	1960	1969	1946	1875	1946	1974	1965	1956	1963	1978	1995	1963
Minimum	1.65	1.23	2.46	1.15	2.11	1.98	1.60	3.09	1.31	1.25	2.70	1.52
Year	1977	1977	1947	1976	1949	1912	1977	1989	1939	1977	1948	1977

Notes: 1/ Gauge located within the Gualala watershed.
2/ Inactive 1970 - 1975 & 1977 - 1997.
3/ Inactive 1921 - 1960 & 1978 - 1982
4/ Inactive 1996.
5/ Inactive 1973 - 1982.
6/ Inactive 1897 - 1902.
7/ Inactive 1970 - 1988.
8/ Inactive 1987 - 1992 & 1997 - 1998.

Chart II-1: Period of record for long-term precipitation gauges within or near the Gualala watershed.

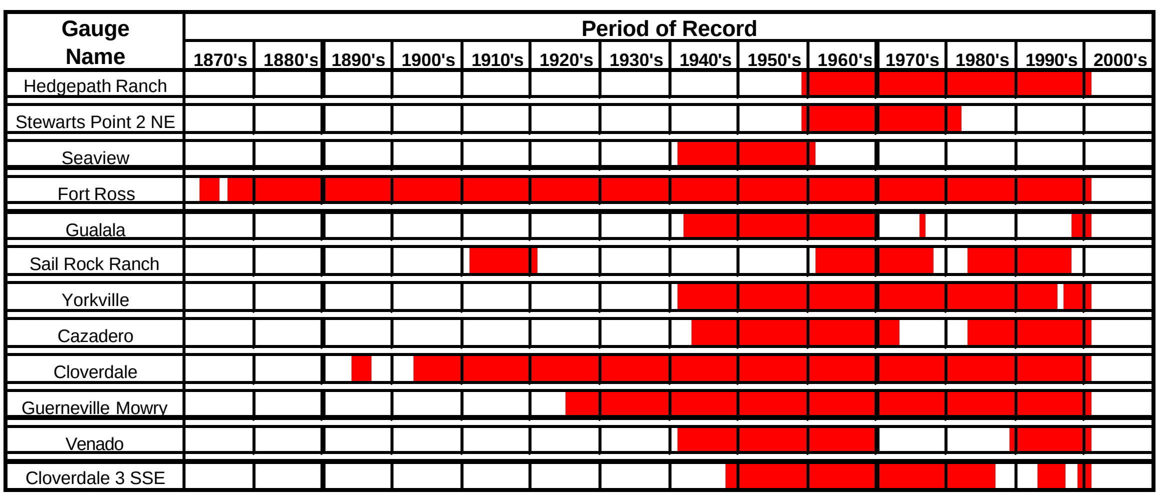


Chart II-3: Annual precipitation and cumulative departure from the mean for the Fort Ross rain gauge (DWR F80 3161 00) for the period 1876 - 2000.

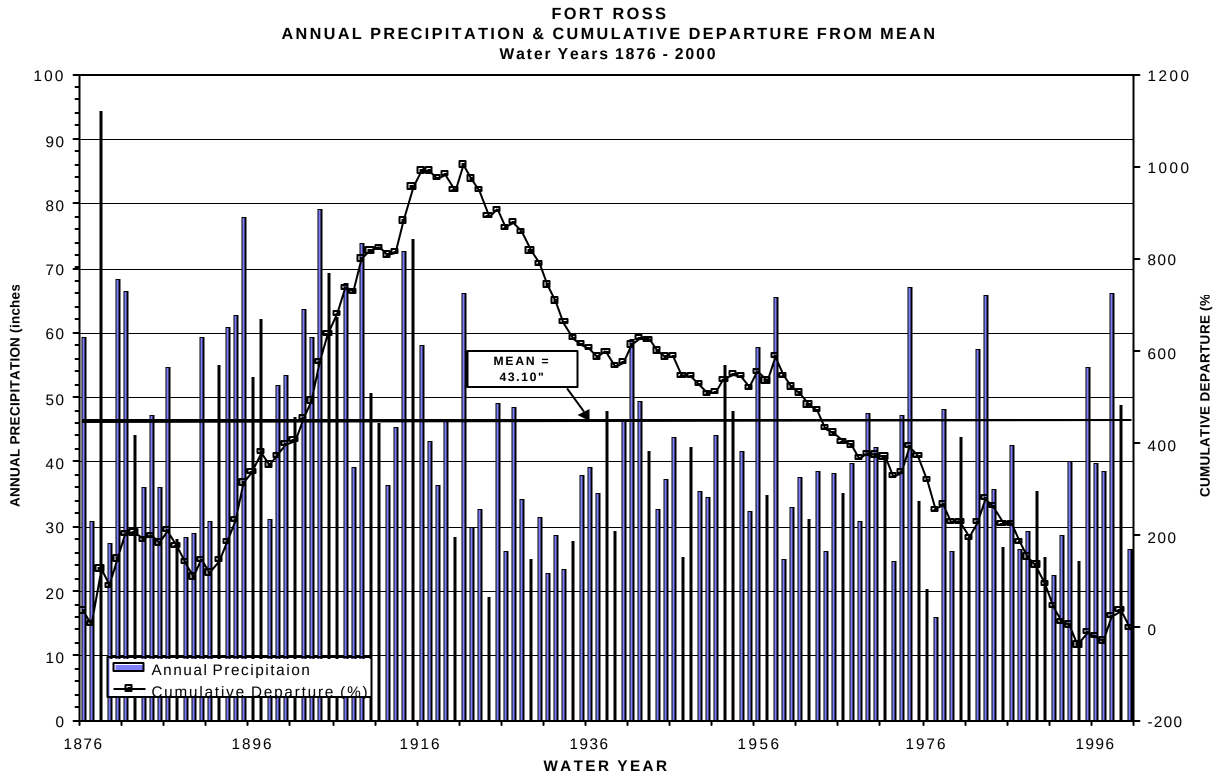
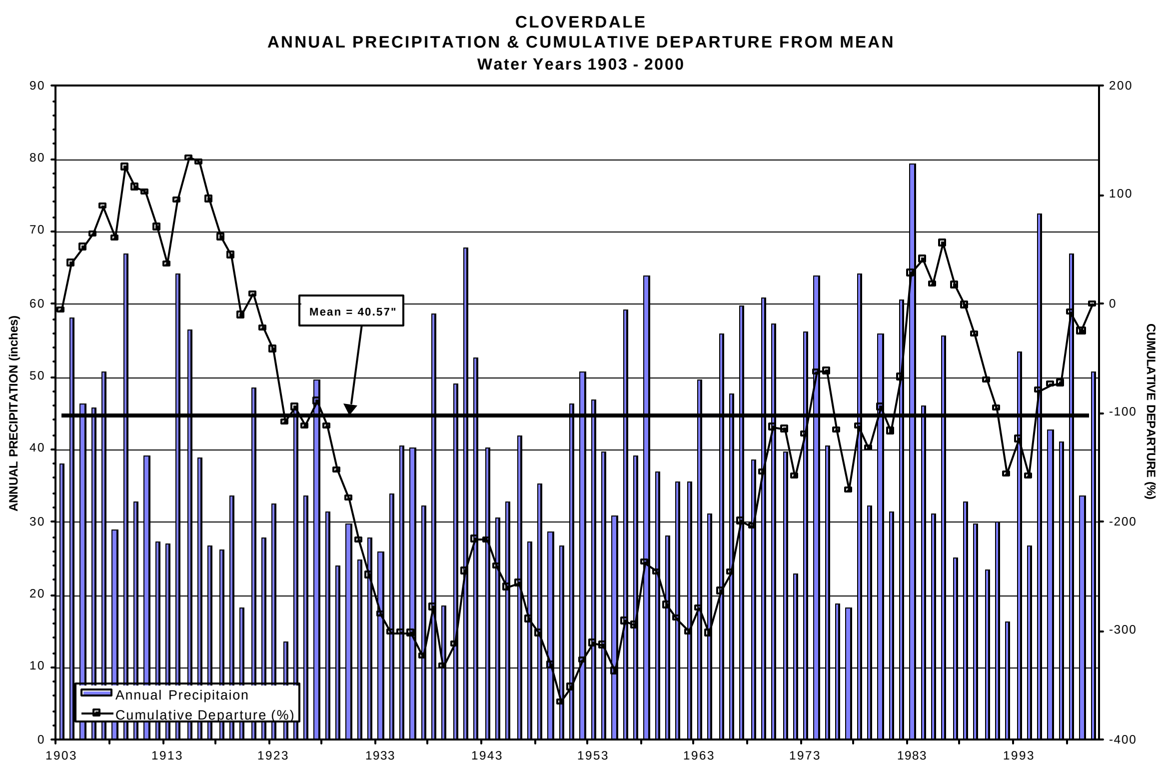


Chart II-3: Annual precipitation and cumulative departure from the mean for the Cloverdale rain gauge (DWR F80 3161 00) for the period 1876 - 2000.



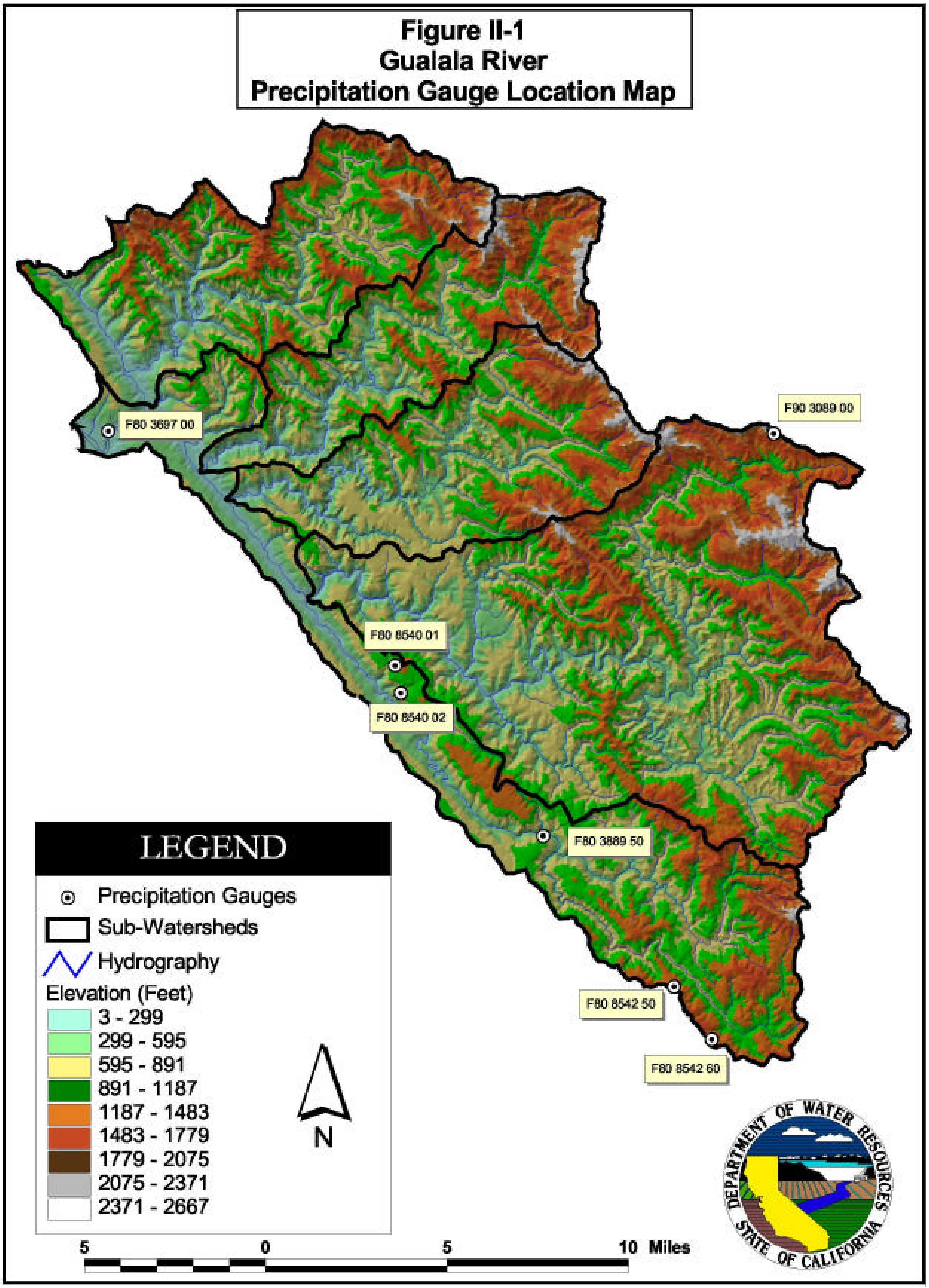


Figure II-1
Gualala River
Precipitation Gauge Location Map
F80 3697 00
F90 3089 00
F80 8540 01
F80 8540 02
F80 3889 50
F80 8542 50
F80 8542 60
LEGEND
Precipitation Gauges
Sub-Watersheds
Hydrography
Elevation (Feet)
3 - 299
299 - 595
595 - 891
891 - 1187
1187 - 1483
1483 - 1779
1779 - 2075
2075 - 2371
2371 - 2667
N
5
0
5
10 Miles
DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

III. STREAM FLOW

Stream flow data are an important component in determining the existing conditions and assisting assessment, restoration, and management activities in North Coast watersheds. Stream flow can be a limiting factor for anadromous fisheries affecting migration and the quantity and quality of spawning, rearing, and refugia areas. Stream flow also has a direct affect on other factors such as water temperature, dissolved oxygen, and sediment and chemical transport. Stream flow data are required to quantify stream sediment and chemical transport total loads and for calibrating hydrologic or hydraulic computer models. Although floodplain management and instream structural design and installation projects are not included in NCWAP, stream flow data is a significant benefit to these as well as other activities including State Water Resources Control Board water right application and license reviews and judicial water supply allocations.

A common complaint of watershed managers is the lack of data and the inability to compare current flow conditions to historic conditions. If long-term data collection programs are not established and supported, water resource managers are forced to sometimes make profound policy, management, and operational decisions based on limited scientific data.

Due to the general lack of stream flow data available within the North Coast region, funding was provided through NCWAP to install and operate stream gauging stations. NCWAP will also provide for the continued operation of selected existing stream gauging stations that are subject to discontinuation due to funding reductions. Additional support for new stream gauging station installation and operation within North Coast watersheds will be provided by the State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP). All new stream flow gauging stations will be equipped with water temperature sensors and some with other water quality sensors for measuring parameters such as turbidity, dissolved oxygen, pH, and conductance. Existing stations may also be equipped with additional water quality sensors. Certain selected stations will be equipped with telemetry to provide a portion of the collected data on a real-time basis via the California Data Exchange Center (CDEC) web site. Real-time stream flow and water quality data will assist in notifying this and other data collection efforts of event sampling opportunities or hazardous conditions for fish survival. Flood forecasters and emergency response personnel will also benefit.

Selection of sites, data collection type, and period of station operation will be based on available funding, existing stations, resumption of discontinued stations for historic comparisons, access, favorable site conditions, and special NCWAP or SWAMP identified needs. Stations located at the terminus of the watersheds or major subbasins where none currently exist will be a priority. Some stations will be operated for the long-term for trend and base correlation analysis, while others may only be operated for short periods. Electronic multiple parameter data loggers will be used at all stations to collect highly detailed time series data, normally every 15 minutes or hourly, for all sensors.

DWR and the USGS will work cooperatively to install and operate the new stream gauging stations. Data quality assurance and control techniques developed by the USGS will be employed. The stations will be constructed to withstand substantial flood events and incidental vandalism. Stations installed for short-term operation will be constructed with the assumption that data collection may be resumed at a later date. About 9 to 12 direct stream discharge measurements along with simultaneous water stage (elevation) data over a wide range of water stages will normally be performed annually at each station. High discharge measurements may require the installation of cableway systems if bridges are not located nearby or if measurements by boat are impractical. Multiple direct field measurements of water stage and water quality parameters will also be performed to verify and calibrate the station sensors.

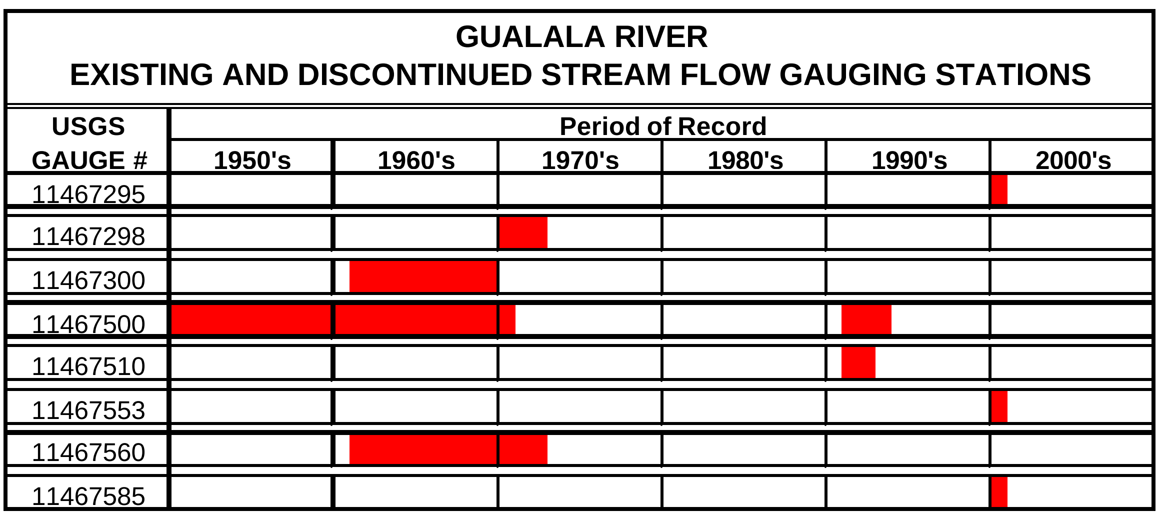
Water stage and water quality time series data will normally be downloaded from the station data loggers and then uploaded into a database and reviewed and edited for accuracy on a monthly basis. Time series stream flow data will be determined by correlating the direct discharge measurements with the simultaneous water stage data. This stage vs. discharge relationship or rating curve is then applied to the stage recordings from the station's stage sensor and data logger to compute stream flow for the same time series interval as water stage, normally every 15 minutes. Once the rating curves are developed, real-time flow data will be provided through the Internet via the CDEC web site for those stations equipped with telemetry. Real-time telemetry also allows the station's operator to monitor the operation of the station remotely allowing a timely response to station malfunctions. Real-time data is normally not reviewed and edited for inaccuracies such as telemetry transmission error, sensor drift or malfunction, or discharge rating curve shift and is considered preliminary and subject to revision. Reviewed finalized data for the October through September water year will normally be available about three to six months after the end of the water year.

Similar to other watersheds within the North Coast, only a few stream flow gauging stations have historically operated within the Gualala watershed. Stream flow data had not been collected by any agency since 1994. To gain additional stream flow data, three stream gauging stations were installed for NCWAP during the fall of 2000. Stations were installed near each of the confluences of the North Fork and Wheatfield Fork with the South Fork and another on the South Fork above the Wheatfield Fork. Combined, the gauges will measure the discharge from about 207 square miles or 69% of the entire drainage basin and provide runoff data from subbasins with varying hydrological, geographical, and land use characteristics. The new Wheatfield and South Fork gauges combined will be comparable to the long-term historic gauge "South Fork Gualala River near Annapolis". The three new gages were also equipped with water temperature sensors. A list of the new and discontinued stream flow gauging stations along with their location, flow data type, and period of record is shown in Table III-1. Chart III-1 graphically illustrates the period of record. A location map is provided in Figure III-1.

Table III-1: Existing and discontinued stream flow gauging stations located within the Gualala watershed.

GUALALA RIVER EXISTING AND DISCONTINUED STREAM FLOW GAUGING STATIONS							
Operating Agency	Station Number	Station Name	1/ Data Type	Drainage Area (sq. mi.)	Elevation (feet)	County	Period of Record
USGS	11467295	S. F. Gualala River above Wheatfield Fork near Annapolis 2/	QC	48.25	75	Sonoma	10/00 - present
USGS	11467298	Unnamed Tributary 1 to Wheatfield Fork Gualala River near Annapolis	QP	0.33	320	Sonoma	10/70 - 9/73
USGS	11467300	Unnamed Tributary 2 to Wheatfield Fork Gualala River near Annapolis	QP	0.19	375	Sonoma	8/61 - 9/70
USGS	11467500	S. F. Gualala River near Annapolis	QC 3/	161	70	Sonoma	10/50 - 9/71, 6/91 - 6/94
USGS	11467510	S. F. Gualala River near the Sea Ranch	QC 4/	161	65	Sonoma	6/91 - 9/92
USGS	11467553	N. F. Gualala River above S. F. Gualala River near Gualala 2/	QC	47.46	30	Mendocino	10/00 - present
USGS	11467560	China Gulch at Gualala	QP	0.54	40	Mendocino	8/61 - 9/73
USGS	11467585	Wheatfield Fork Gualala River above S. F. Gualala River near Annapolis 2/	QC	111.36	75	Sonoma	10/00 - present
Notes: 1/	QP = annual peak flow only. QC = continuous flow record.						
2/	New stations installed and operated for NCWAP.						
3/	No record for flow greater than 1,000 cfs for the period 6/91 - 6/94.						
4/	No record for flow greater than 30 cfs.						

Chart III-1: Period of record for stream flow gauging stations located within the Gualala watershed.



Installation of the new gauges by DWR and the USGS began in November 2000. The date of the actual recording of stage and water temperature data for each station and sensor varied. The USGS operated the gauges during the water year 2001and have provided preliminary data for stage, discharge, and water temperature. It is usual USGS practice to estimate mean daily data back to the beginning of the water year prior to the actual recording of data by the station's sensors if the recording of data began early in the water year and during periods of sensor malfunction. Final edited and reviewed data by the USGS for the entire water year is normally not available until three to six months after the end of the water year. Charts III-2 and III-3 graphically show the daily flow and water temperature for the three gauges for water year 2001. Chart III-4 shows the daily maximum and minimum water temperatures for the North Fork gauge.

The flow at the Wheatfield and South Fork gauges was zero for periods during the late summer months. In the fall of 2001, no surface flow was observed in the lower portions of the Wheatfield Fork and South Fork, whereas in 1976 - 77 surface flows were low, but maintained through the summer (NCWQCB 2001). In October 2000, while investigating potential stream gauging station sites along the lower portions of the Wheatfield and South Forks, no surface flow was also observed at certain locations while measurable flow was present upstream or downstream. Underlying bedrock outcrops and aggradation of the streambed probably result in the surfacing and sub-surfacing of water flow in the lower portions of the major tributaries. The data also show that the North Fork maintained a minimum base flow and was the only contributor to surface flow to the estuary during the early fall of 2000 and the late summer of 2001.

Only one stream flow gauge, "South Fork Gualala River near Annapolis", USGS gauge #11467500, operated for a significant period (October 1950 - September 1971 and June 1991 – June 1994). This station was located below the confluence with the Wheatfield Fork and measured the runoff from 161 or 54% of the total 298 square mile Gualala River watershed. During the period of 1991 – 1994, the gauge was operated to record low flows only. A summary and statistical analysis of the flow data for this station follows.

Table III-2 shows the mean monthly flows for the period of record. Chart III-5 graphically illustrates the mean, maximum, and minimum daily flows for each day of the water year for the period of record. Chart III-6 shows the annual yield or runoff volume in acre-feet and the cumulative departure from the mean for the period of record. Chart III-7 presents daily flow duration for the period of record.

A frequency analysis for annual peak and low-flow was completed using the techniques from the USGS Bulletin number 17B, Techniques of Water-Resources Investigation of the USGS and Ven Te Chow's Handbook of Hydrology. The data used for the peak flow frequency were the annual instantaneous values. For this analysis the Gringorten plotting position equation was used, as it tended to give better results when using the normal distribution. Table III-3 shows the ranked data, plotting position, and frequencies. Chart III-8 shows the peak discharge for the period of record with the 5-percent moving average superimposed. The moving average describes the general trend of a series. The information from Table III-3 was then utilized to graphically represent peak discharge in the form of return period. See Charts III-9. The return period depicts the theoretical return period in years that the event will be equaled or exceeded.

The low-flow frequency analysis was similar to the peak-flow analysis except that the discharge values were found by calculating the 7-day running average of the mean daily flows for each water year. These values were then used to complete the frequency analysis described above. Table III-4 shows the ranked data, plotting position, and frequencies. Chart III-11 shows the low-flow for the period of record with the 5-percent moving average. Chart III-12 presents the return periods.

Excluding the period June 1991 – June 1994 when the gauge was operated during low flows only, twenty-one years of record are available for the South Fork Gualala gauging station. The USGS recommends a minimum of 20 years of flow data to perform a detailed frequency analysis. Therefore, the computed return periods and exceedance probabilities for peak and low flows are considered estimates only. Long-term precipitation gauges in the area indicate the 1951 – 1971 period of record for the gauge was above average.

The two highest flood events during the 21-year operation of the gauge occurred December 22, 1955 at 55,000 cfs and January 19, 1966 at 47,800 cfs with computed return periods of 38 and 14 years, respectively. Seven other annual events during the operation of the gauge exceeded 30,000 cfs. While other North Coast rivers experienced near record flood flows in December 1964, the South Fork Gualala gauge recorded only 21,000 cfs. An examination of other stream flow gauges in the area indicates recent flood events at the South Fork Gualala gauge site of 30,000 cfs or greater probably occurred in 1974, 1983, 1986, 1993, 1995, and 1997.

Three out of the four lowest annual seven-day running average low flows occurred during water years 1967 – 1971 although these were above average run-off years. The 5-year moving average trend line shown in Chart III-11 indicates a general decline in low flows beginning in water year 1966 and continuing until the gauge was discontinued in September 1971. As stated earlier in this report, aggradation of the stream channels has probably resulted in the sub-surfacing of surface water flow in the lower reaches of the major tributaries. This aggradation may have been the result of the transport of bedload and suspended sediment material during the large flood events of 1955 and 1966.

Chart III-2: Daily discharge for the three new stream gauges within the Gualala watershed. Log scale was used to magnify the low flow data.

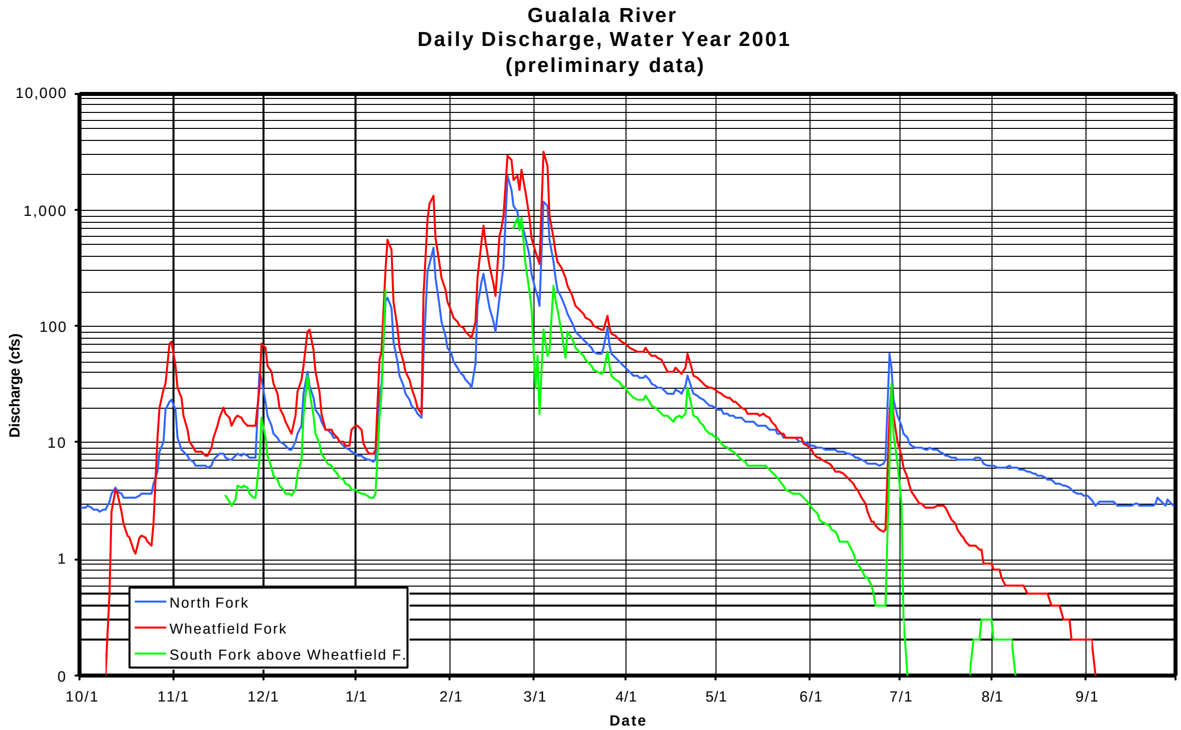


Chart III-3: Daily water temperature for the three new stream gauges within the Gualala watershed. Although no flow occurred at the gauging sites, water temperature sensors were submerged in pools.

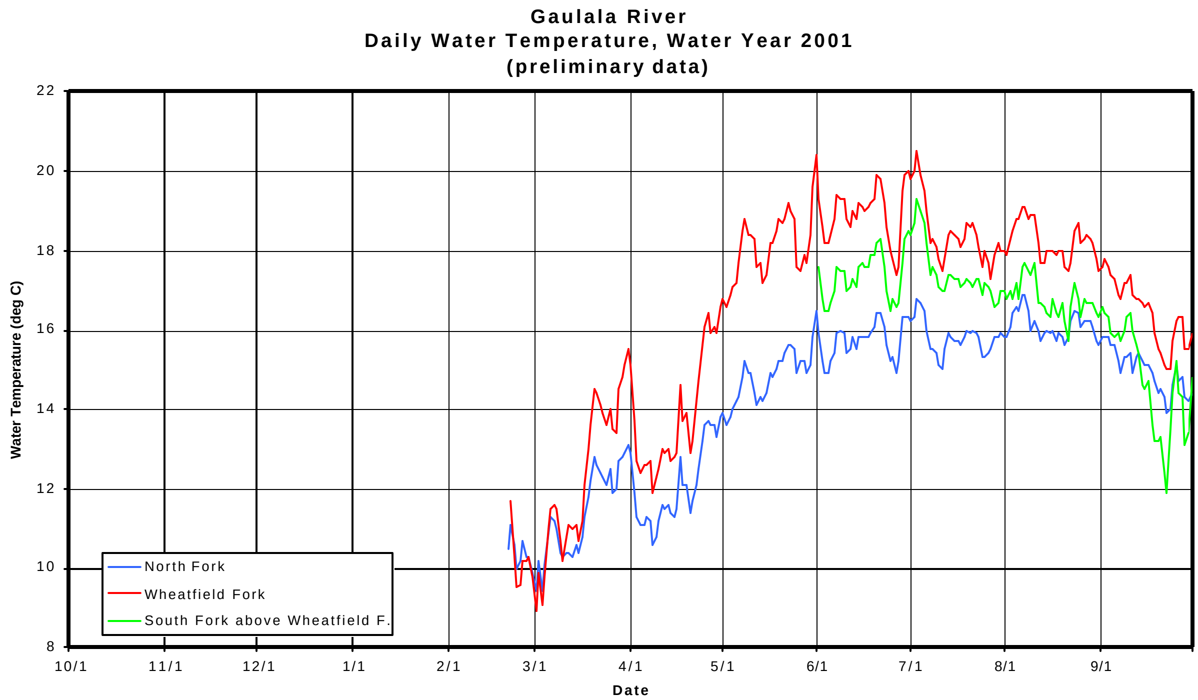


Chart III-4: Daily maximum and minimum water temperature for new North Fork Gualala River gauge.

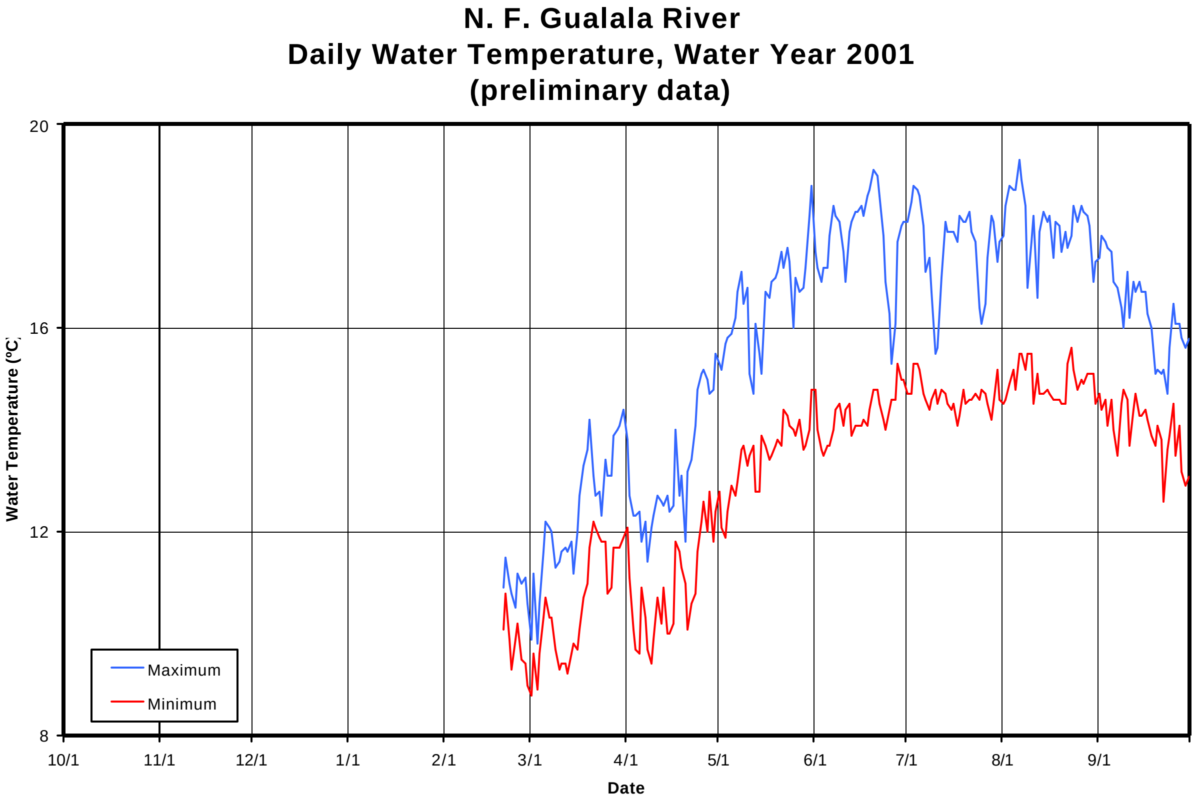


Table III-2: Summary of monthly mean discharge for the period of record for "South Fork Gualala River near Annapolis", USGS station #11467500.

SOUTH FORK GUALALA RIVER NEAR ANNAPOLIS
USGS GAUGE #11467500
MEAN MONTHLY DISCHARGE AND ANNUAL YIELD
WATER YEARS 1951-1971 and 1991-1994
(units in cfs, NR = no record)

Water	Month															WR	Yield
Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Min	Max	Avg	Mean	(ac-ft)
1951	NR	NR	1,343	1,420	1,280	747	98	159	28	12	4	2	NR	NR	NR	NR	NR
1952	21	312	2,343	2,111	1,140	905	167	89	34	17	7	4	4	2,343	596	7,150	434,118
1953	4	18	1,847	2,501	135	481	362	163	53	19	9	7	4	2,501	466	5,597	342,446
1954	14	343	270	2,165	863	843	983	109	40	14	25	11	11	2,165	473	5,680	341,394
1955	15	375	782	588	147	83	658	135	33	13	5	4	4	782	237	2,839	171,556
1956	6	88	3,060	2,367	1,650	273	102	78	27	11	5	5	5	3,060	639	7,671	464,709
1957	38	24	15	482	1,039	943	309	660	103	24	9	90	9	1,039	311	3,735	222,413
1958	736	225	577	1,322	4,407	870	1,256	98	61	20	9	6	6	4,407	799	9,587	560,214
1959	7	20	22	1,134	1,533	164	88	33	14	4	3	36	3	1,533	255	3,057	178,536
1960	11	8	13	510	1,713	1,188	188	78	31	13	6	5	5	1,713	314	3,765	224,221
1961	8	87	979	586	1,586	1,034	172	68	30	9	5	4	4	1,586	381	4,569	270,907
1962	6	266	417	260	2,385	1,023	119	52	21	11	5	6	5	2,385	381	4,572	266,079
1963	434	71	560	663	1,144	643	1,401	152	47	21	11	7	7	1,401	430	5,154	307,082
1964	37	879	146	820	150	135	56	32	18	8	4	3	3	879	190	2,285	138,031
1965	22	481	2,276	1,589	273	162	955	118	44	18	10	6	6	2,276	496	5,954	361,541
1966	7	461	544	1,312	906	448	151	51	22	12	6	2	2	1,312	327	3,922	234,512
1967	1	556	1,028	1,909	390	905	866	159	77	21	8	5	1	1,909	494	5,925	359,023
1968	13	36	338	972	1,043	632	124	52	21	9	9	7	7	1,043	271	3,256	195,696
1969	24	61	1,284	2,677	1,798	488	240	66	31	12	5	4	4	2,677	558	6,690	400,006
1970	15	25	1,445	4,152	613	314	73	33	14	3	2	2	2	4,152	558	6,691	407,564
1971	8	395	2,259	1,357	132	858	244	72	29	11	5	4	4	2,259	448	5,375	328,354
1991	NR	NR	NR	NR	NR	NR	NR	NR	12	5	2	1	NR	NR	NR	NR	NR
1992	13	22	NR	183	NR	NR	182	45	20	11	3	2	NR	NR	NR	NR	NR
1993	12	16	NR	NR	NR	NR	337	196	197	42	14	6	NR	NR	NR	NR	NR
1994	5	21	NR	NR	NR	117	61	35	12	NR	NR	NR	NR	NR	NR	NR	NR
Min	1	8	13	183	132	83	56	32	12	3	2	1					
Max	736	879	3,060	4,152	4,407	1,188	1,401	660	197	42	25	90					
Avg	63	208	1,026	1,413	1,159	603	383	114	41	14	7	9					

Chart III-5: Mean, maximum, and minimum daily flow for each day of the water year for Water Years 1951 - 1971 for "South Fork Gualala River near Annapolis", USGS station #11467500.

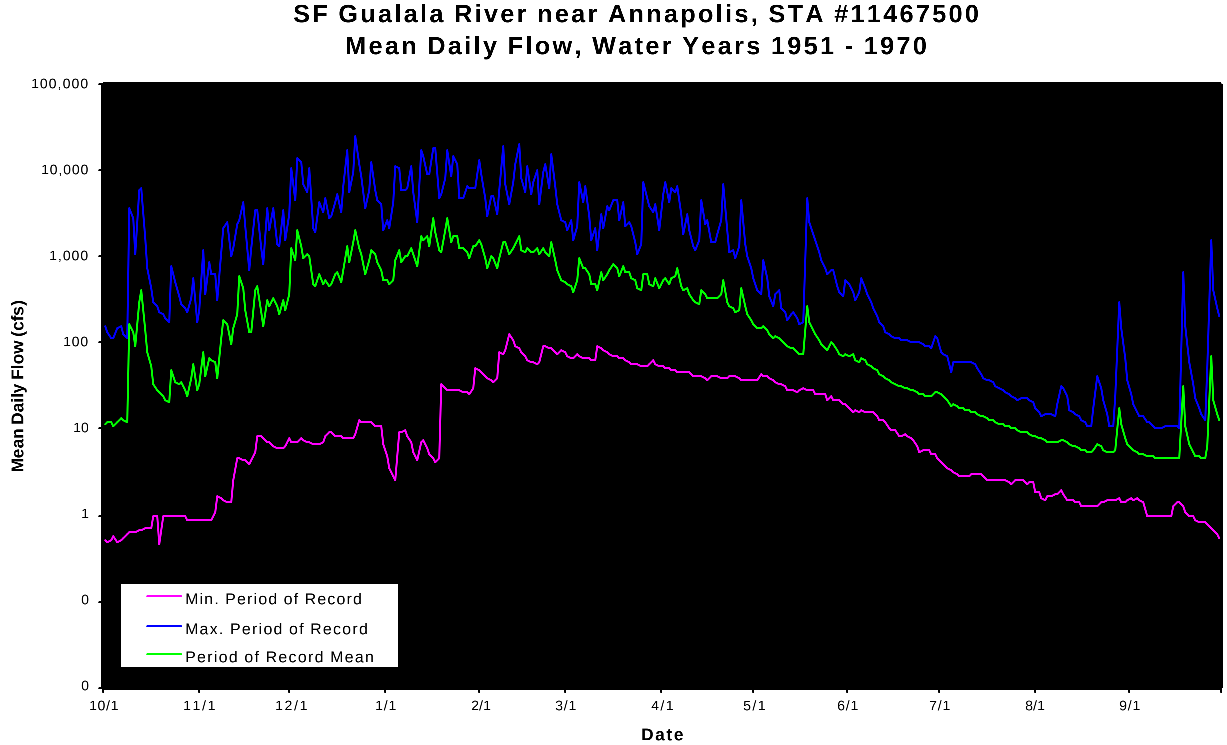


Chart III-6: Annual yield and cumulative departure from the mean for Water Years 1952 – 1971 for "South Fork Gualala River near Annapolis", USGS station #1467500.

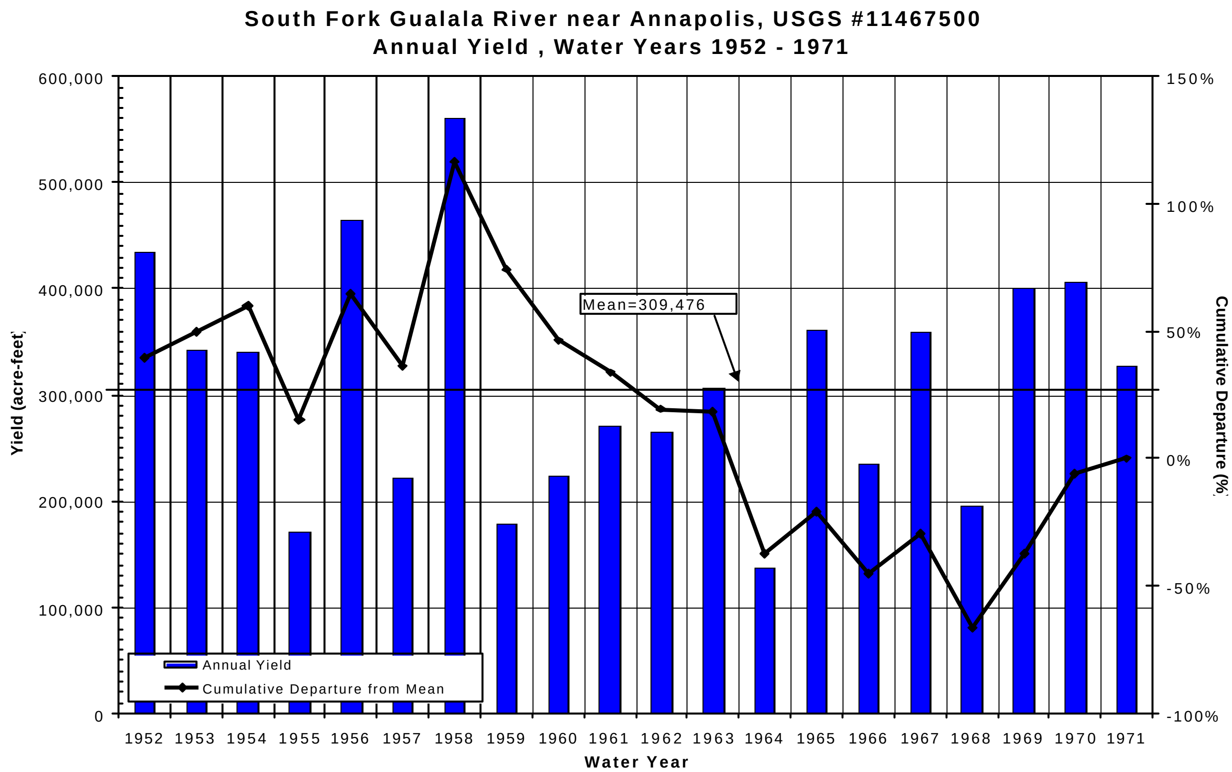


Chart III-7: Daily flow duration for Water Years 1951 - 1971 for "South Fork Gualala River near Annapolis", USGS station #1146750.

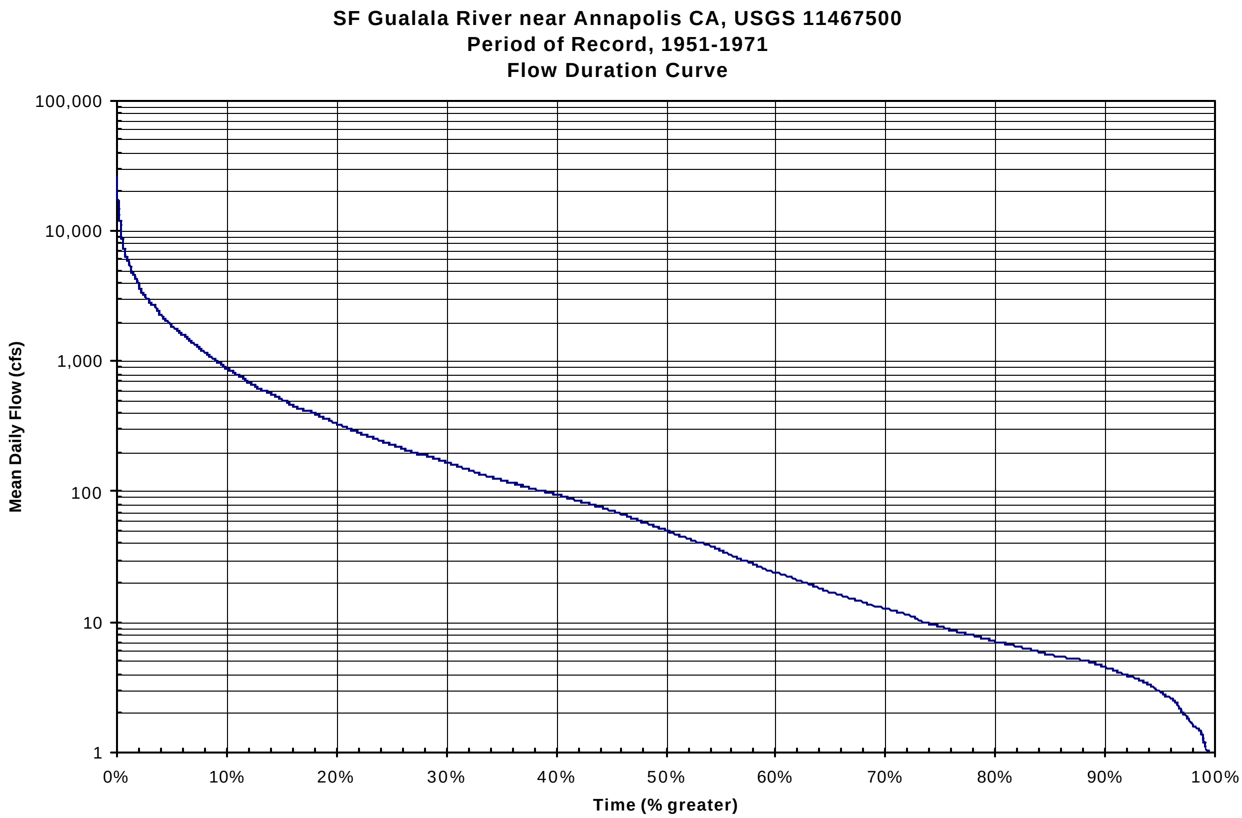


Table III-3: Annual peak instantaneous discharge and frequency analysis for Water Years 1951 – 1971 for "South Fork Gualala River near Annapolis", USGS station #11467500.

PEAK DISCHARGE FREQUENCY ANALYSIS GUALALA RIVER NEAR ANNALPLIS, STA# 11467500 PERIOD OF RECORD--WATER YEARS(1951-1971)						
PEAK DISCHARGE			FREQUENCY ANALYSIS			STATISTICS
Rank	Water Year	Peak Discharge (cfs)	Gringorten Return Period (yr.)	Frequency	Exceedence Probability	Statistical Moments of Discharge
1	1956	55000	37.71	0.973	0.027	
2	1966	47800	13.54	0.926	0.074	
3	1962	37700	8.25	0.879	0.121	Mean = 28234.76
4	1954	35900	5.93	0.831	0.169	
5	1970	35800	4.63	0.784	0.216	SDEV = 11888.37
6	1958	35400	3.80	0.737	0.263	
7	1951	34100	3.22	0.689	0.311	Variance = 1.41E+08
8	1953	33900	2.79	0.642	0.358	
9	1960	33700	2.47	0.595	0.405	Skew = 0.27
10	1952	29500	2.21	0.547	0.453	
11	1969	29100	2.00	0.500	0.500	
12	1967	28900	1.83	0.453	0.547	
13	1971	27900	1.68	0.405	0.595	
14	1963	23000	1.56	0.358	0.642	
15	1965	21400	1.45	0.311	0.689	
16	1959	19100	1.36	0.263	0.737	
17	1961	15900	1.28	0.216	0.784	
18	1968	15200	1.20	0.169	0.831	
19	1964	15000	1.14	0.121	0.879	
20	1955	9870	1.08	0.074	0.926	
21	1957	8760	1.03	0.027	0.973	

Table III-4: Annual minimum seven-day running low flow and frequency analysis for Water Years 1951 - 1971 for "South Fork Gualala River near Annapolis", USGS station #11467500.

LOW FLOW FREQUENCY ANALYSIS FOR GUALALA NEAR ANNAPOLIS, STA#11467500, POR-1950-1970 7 Day Average Discharge						
Ranked Data			**Frequency Analysis**			**Statistics**
Rank	Water Yr.	Discharge 7-Day Ave., cfs	Gringorten Return Period	Frequency	Exceedence Probability	Statistical Moments of Discharge
1	1971	0.5	37.71	0.973	0.027	
2	1970	0.7	13.54	0.926	0.074	
3	1967	0.9	8.25	0.879	0.121	Mean = 4.77
4	1951	1.0	5.93	0.831	0.169	
5	1966	1.3	4.63	0.784	0.216	SDEV = 8.12
6	1959	2.3	3.80	0.737	0.263	
7	1969	2.4	3.22	0.689	0.311	Variance = 65.97
8	1956	2.7	2.79	0.642	0.358	
9	1964	2.8	2.47	0.595	0.405	Skew = 3.71
10	1955	3.1	2.21	0.547	0.453	
11	1953	3.1	2.00	0.500	0.500	
12	1952	3.4	1.83	0.453	0.547	
13	1965	3.4	1.68	0.405	0.595	
14	1962	3.6	1.56	0.358	0.642	
15	1961	3.7	1.45	0.311	0.689	
16	1957	4.1	1.36	0.263	0.737	
17	1960	4.2	1.28	0.216	0.784	
18	1968	4.4	1.20	0.169	0.831	
19	1958	4.8	1.14	0.121	0.879	
20	1954	5.4	1.08	0.074	0.926	
21	1963	6.1	1.03	0.027	0.973	

Chart III-8: Annual instantaneous peak discharge and 5-year moving average for Water Years 1951 - 1971 for "South Fork Gualala River near Annapolis", USGS station # 11467500. The 5-year moving average illustrates the runoff trend.

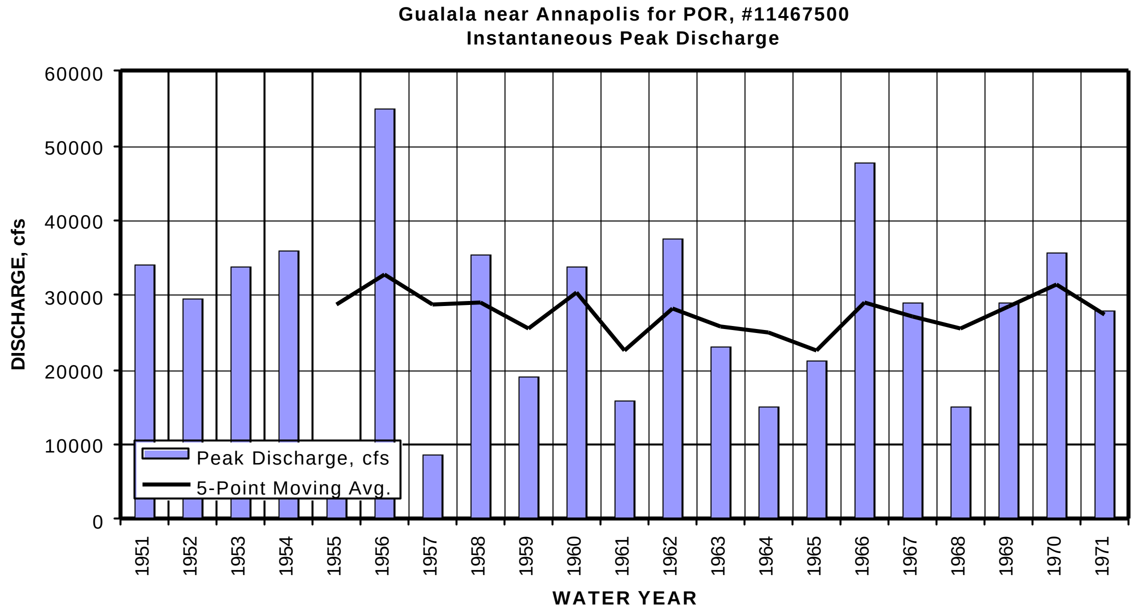


Chart III-9: Annual peak flow return period for the period of record for "South Fork Gualala River near Annapolis", USGS station #11467500. Graph shows the theoretical return period in years that a given value will be equaled or exceeded.

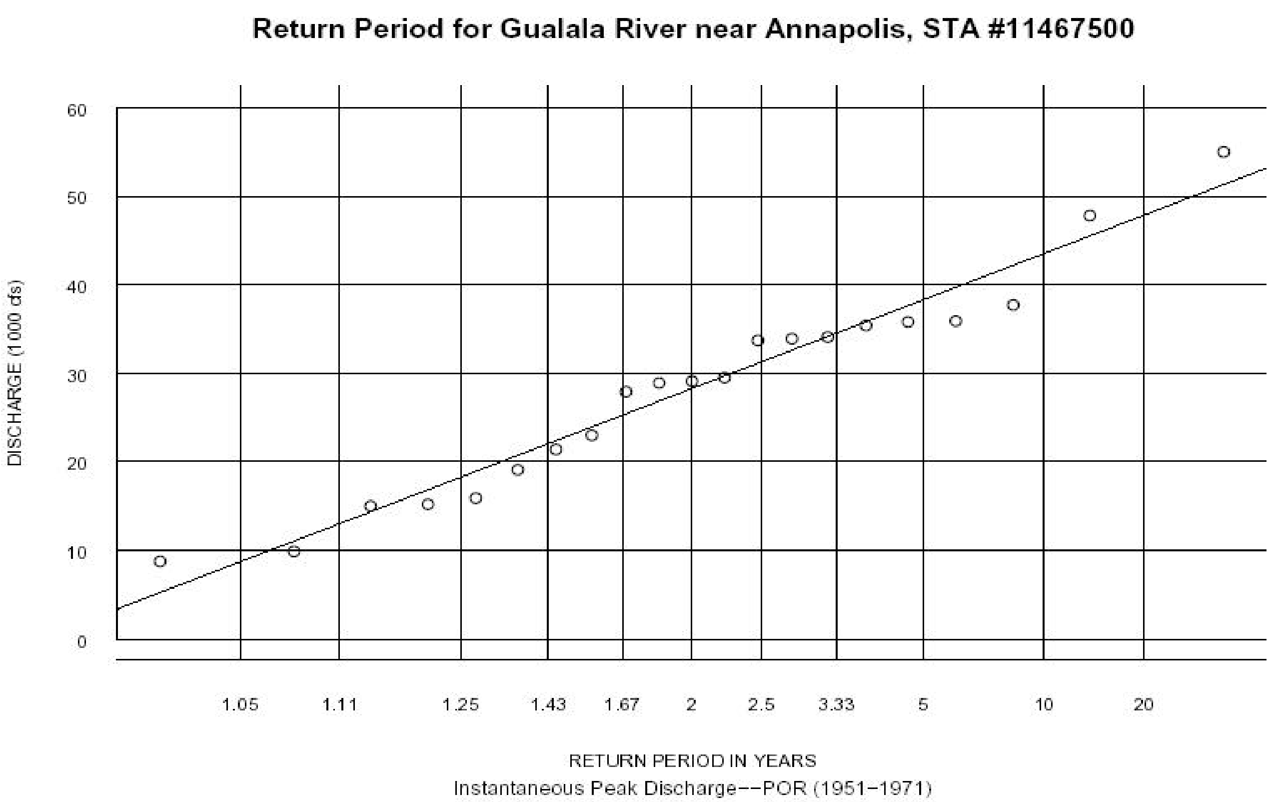


Chart III-10: Annual seven-day running low flow and the 5-year moving average for Water Years 1951 – 1971 for "South Fork Gualala River near Annapolis", USGS station #11467500.

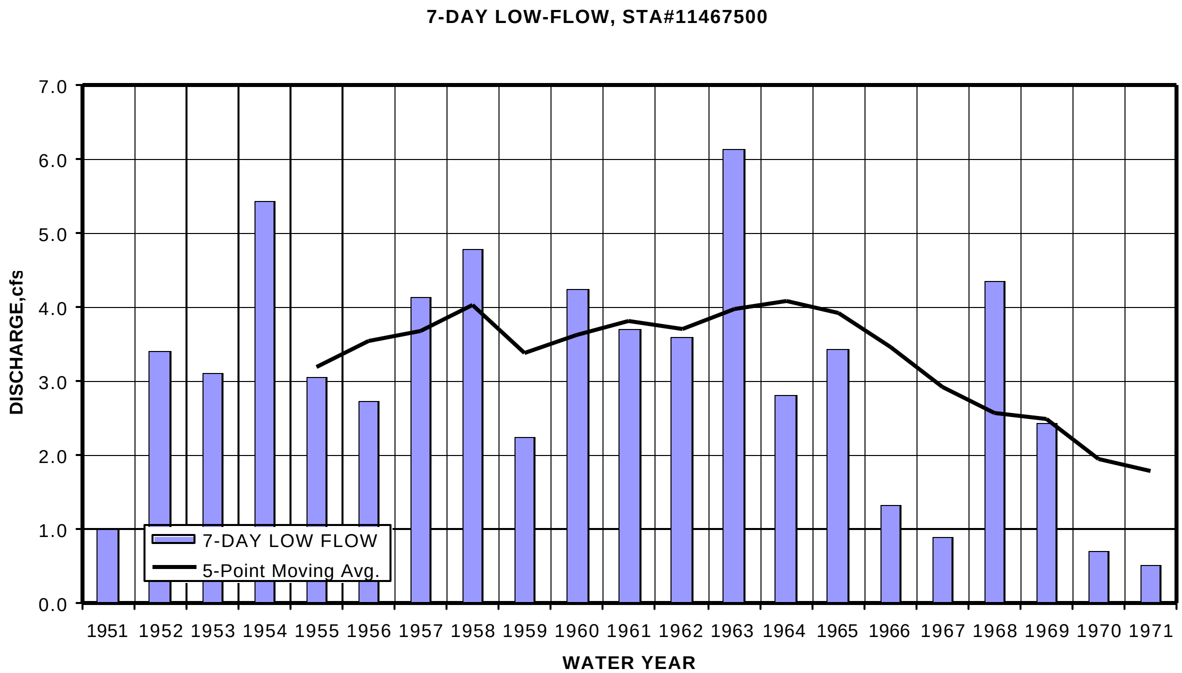
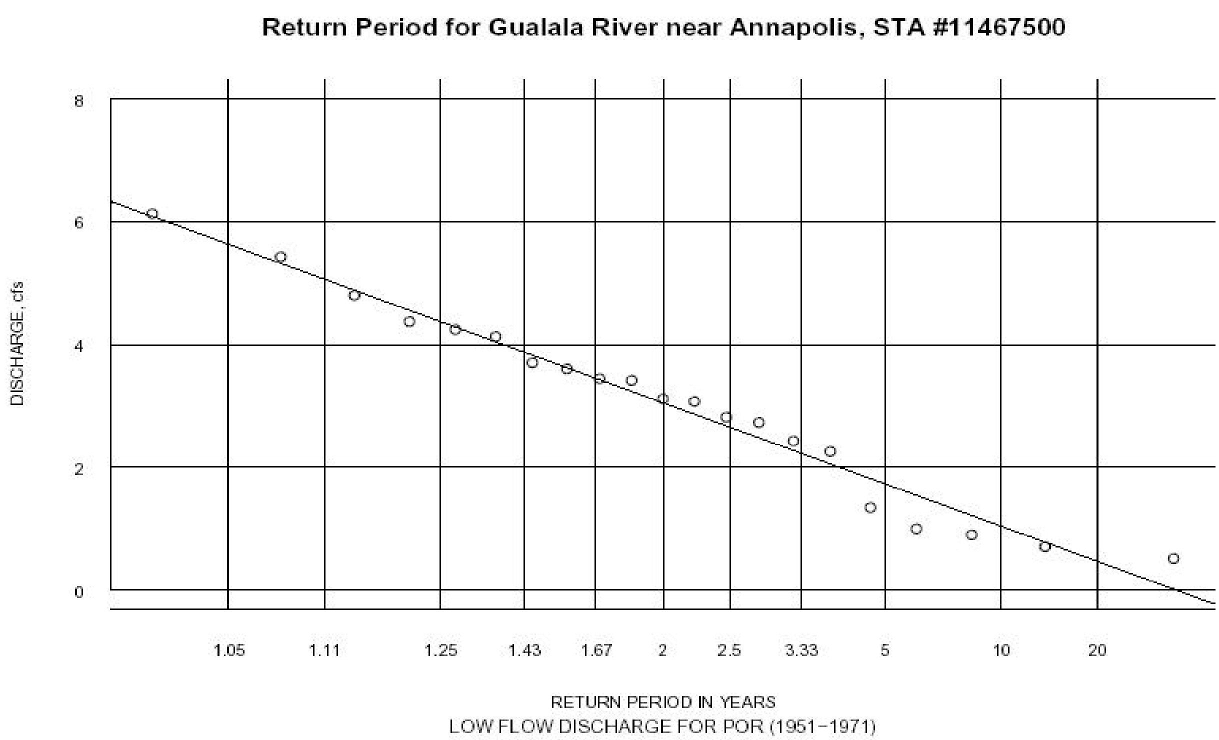


Chart III-11: Annual seven-day running average low-flow return period for the period of record for "South Fork Gualala River near Annapolis", USGS station #11467500. Graph shows the theoretical return period in years that a given value will be equaled or exceeded.



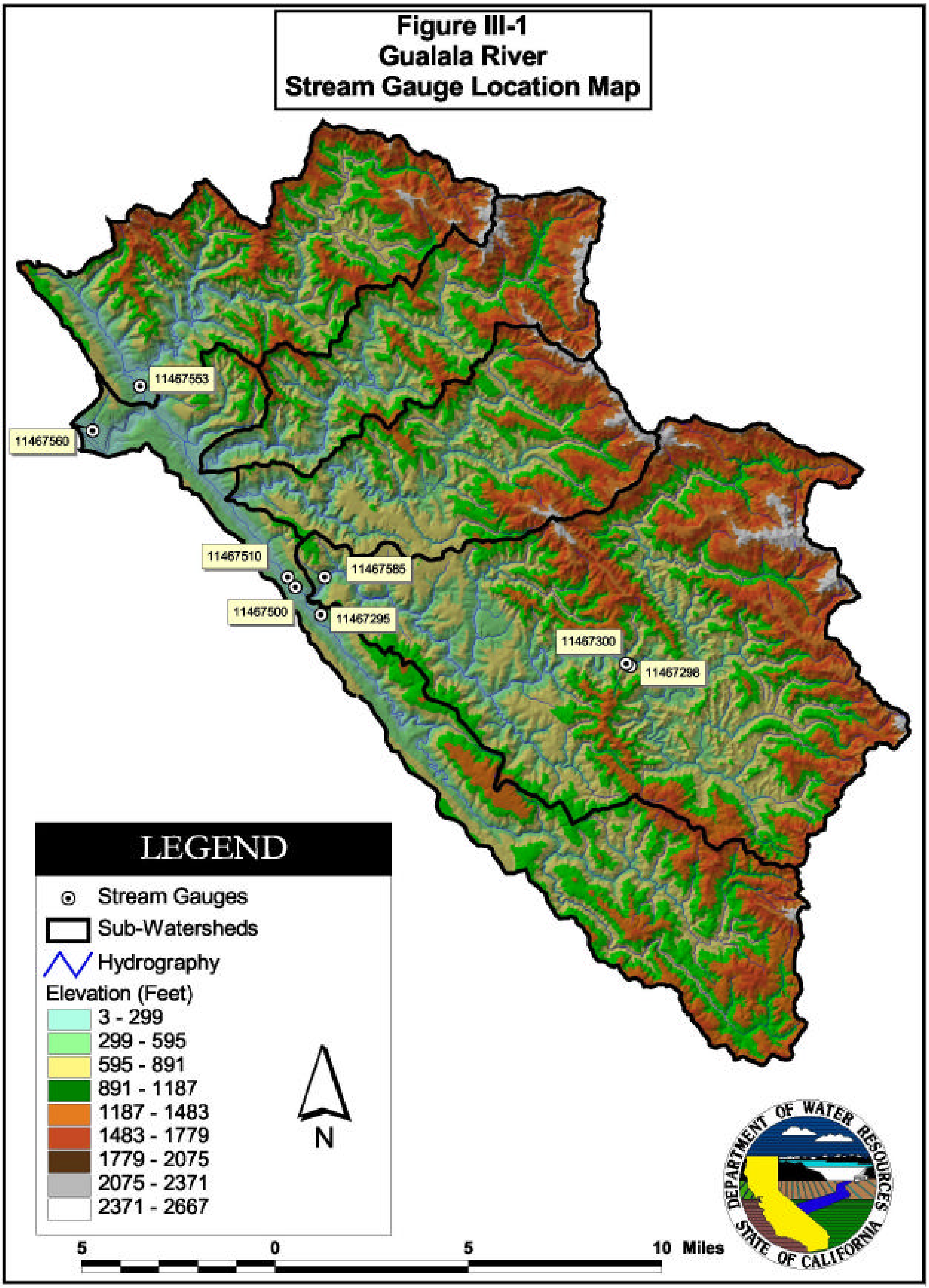


Figure III-1
Gualala River
Stream Gauge Location Map

IV. SURFACE WATER RIGHTS AND WATER USE

California law recognizes various types of water rights to surface water flow. Their proof of existence and exercise can often be a complicated and controversial issue. Surface water diversions can have a major impact on stream flow and consequently fisheries habitat. Ground water extractions, with a few exceptions, are not subject to California law and can also affect stream flow. A description of the different types of surface water rights can be found at the State Water Resources Control Board (SWRCB) web site (waterrights.ca.gov). A more detailed description is published in an article in the Pacific Law Journal, Volume 19, and Issue 4, entitled “Overview of California Water Law” by William R. Atwater and James Merkle.

The two predominate types of water rights within the Gualala River watershed are riparian and appropriative. The pueblo water right, distinctly recognized by California water law, is very rare and pertains to the right of a city, as the successor of a Spanish or Mexican pueblo (municipality), to the use of water naturally occurring within the old pueblo limits for the use of the inhabitants (Hutchins, 1956). This type of water right has not been established within the Gualala watershed and is not discussed further.

Riparian water rights generally apply to the diversion and use of surface water from a natural watercourse on lands that the watercourse passes through or borders. No California statute defines riparian rights and a State permit is not required, but a riparian water rights doctrine has been established in the State by decisions of the courts and confirmed by Section 3, Article XIV of the California constitution.

Common restrictions and conditions that apply to all riparian water rights include: 1.) the diversion of water is limited to natural flowing water as distinguished from return flows derived from the use of ground water, water seasonally stored and later released, or water diverted from another watershed; 2.) a parcel of land losses its riparian right if it is severed from the land bordering the watercourse unless the right is reserved by deed for the severed parcel: 3.) they are of equal priority with all other riparian rights to the same natural flow of a watercourse regardless of the date of initial use: 4.) they are neither created by use nor lost by nonuse; 5.) they can not be transferred to another parcel of land but can be dedicated to instream flow purposes; 6.) a “Statement of Water Diversion and Use” is required, with certain exceptions, to be filed periodically with the SWRCB. This statement establishes a record of actual water use.

Appropriative water rights generally apply to the diversion and use of water on lands that do not border the watercourse. Appropriative water rights are divided into two types, those initiated before December 1914 (pre-1914) and those initiated after December 1914 (post-1914).

Prior to enactment of the California Water Commission Act in December 1914, the appropriation of water from surface streams was obtained in accordance with the guidelines in Sections 1410 through 1422 of the California Civil Code of 1872. To appropriate water, it was necessary to post a notice at the proposed point of diversion and record a copy of the notice with the respective county recorder. The right was considered valid as long as the appropriator maintained continuous beneficial use of the water. The amount that could be rightfully claimed was fixed by actual beneficial use as to both amount and season of diversion.

In 1914, the California Water Commission Act abolished the procedures previously followed for water appropriation, and established an application process. Water appropriation now requires compliance with the provisions of Division 2, Part 2 of the California Water Code. These provisions established the steps that must be followed to initiate and acquire an appropriative water right. The purpose of filing an application for a permit is to secure a right to the use of unappropriated water and to establish a record of the right so that its status relative to other rights may be determined.

A prospective appropriator must file an application with the SWRCB. The application includes all information pertinent to the development, acquisition, and use of the water, including point of diversion, diversion flow rates, time of diversion, quantity of diversion, and place and purpose of use. The application is then reviewed by the SWRCB. The review process includes: 1.) posting or publication of the application. If protests are received, a hearing or investigation is conducted; 2.) availability of unappropriated water; 3.) possible environmental impacts as required by the California Environmental Quality Act; 4.) possible fisheries impacts by the California Department of Fish and Game.

Although ground water extractions do not generally require a SWRCB application, underground water extractions from "subterranean streams flowing through known and definite channels" are under the SWRCB jurisdiction and are subject to the same review as surface water extractions.

If the application is approved, a permit is issued with terms and conditions to develop the diversion facilities. If the terms and conditions are completed and adhered to during a specific time frame, a license is issued limiting the water user to a quantity of water that was demonstrated as beneficially used during the permitting process. The terms and conditions set by the SWRCB normally apply after the license is issued.

Common conditions and restrictions that apply to all pre-1914 and post-1914 appropriative water rights include: 1.) appropriation of water can be from the natural flow of a watercourse, return flows derived from the use of surface or ground water, water seasonally stored and later released, or water diverted from another watershed; 2.) they can be transferred to other lands or for instream flow purposes; 3.) they typically follow the "first in time, first in right" doctrine of priority among other appropriators but are inferior to riparian water rights. There may be times during the diversion season when no unappropriated water is available; 4.) they can be lost after five years of nonuse; 5.) a "Statement of Water Diversion and Use" is required , with certain exceptions, to be filed periodically with the SWRCB. This statement provides a record of actual water use.

Disputes over the exercise of surface water rights occur and can occasionally only be resolved by court litigation. The SWRCB is authorized to pursue civil action if a water user violates the terms of a post-1914 appropriative water right, but does not have the authority to determine the validity of other vested water rights. The County Superior Courts are sometimes compelled to adjudicate water rights as a result of disputes that can not be resolved by other methods. A typical water right adjudication defines numerous aspects of the water rights involved including the quantity of use, priority to other vested water rights, point of diversion, and the purpose, place and season of use. Court adjudicated water rights do not currently exist within the Gualala watershed.

A search of the SWRCB's Water Right Information System (WRIMS) was performed to determine the number and types of water rights within the Gualala watershed. The WRIMS database is under development and may not contain all post-1914 appropriative water right applications that are on file with the SWRCB at this time. Some pre-1914 and riparian water rights are also contained in the WRIMS database for those water rights whose users have filed a "Statement of Water Diversion and Use". A list of water rights and associated information contained within WRIMS for the Gualala watershed is presented in Table IV-1. A location map of the point of diversion is shown in Figure IV-1.

According to Table IV-1, SWRCB appropriative water right permits exist for a total of about 4,500 acre-feet per year (ac-ft/yr) of water from the Gualala River watershed, at a maximum diversion rate of about 8.0 cubic feet per second (cfs).

Because the watershed is sparsely populated, current riparian extraction in the watershed is probably minimal. The potential peak demand from this use and additional future riparian uses in the watershed was estimated to be 2.5 cfs (EIP, 1994).

The California Department of Water Resources (DWR) periodically conducts land and water use surveys for its Statewide Planning Program. DWR uses this data to estimate water use during an average water supply year and future water use demands for each detailed analysis unit (DAU) of the State and publishes the information in the Bulletin 160 series. The latest land use survey by DWR was performed in 1986. At that time, no irrigated acres were identified within the Gualala watershed. DWR also uses population data to estimate municipal water use. Table IV-2 presents population and municipal water use data for the Gualala watershed.

Table IV-2: Population and municipal water use.

GUALALA RIVER POPULATION AND MUNICIPAL WATER USE DWR Detailed Analysis Unit #19				
		Municipal Water Use (ac-ft/yr)		
Year	Permanent Population	Surface Water	Ground Water	Total
1995	1,705	0	150	150
2020	2,160	0	190	190

Although municipal use is the dominant water use in the watershed, other uses of surface water include domestic, irrigation, stockwatering, fish and wildlife enhancement, and fire protection.

Current water use in the Gualala River watershed by agriculture and rural development is probably minor. However, as stated in the Gualala River Watershed Literature Search and Assimilation (Higgins 1997): "While agricultural water use in the Gualala River watershed has been very low in the past," vineyards " are now being developed in some areas. These wineries may have a direct impact on tributary flow if surface water is used. If wells are drilled in upland areas, and if the aquifer is joined to headwater springs, flows in some tributaries could be affected". EIP Associates (1994) projected that development of vacation homes or residences could result in use of up to 2.5 cfs for the entire basin.

Two major municipal water users, the North Gualala Water Company (NGWC) and the Sea Ranch, currently extract water from the Gualala watershed. The SWRCB issued an appropriative water right permit to NGWC to divert water from the North Fork Gualala River. The permit stipulates a maximum diversion of 2.0 cfs, but when the natural flow of the North Fork falls below stipulated by-pass flows for fish, NGWC is prohibited from diverting any water from the North Fork. The by-pass flows vary with the time of year, but a minimum by-pass flow of 4.0 cfs is required at all times. In August 2000, the State Water Resources Control Board ruled that the by-pass flows applied to both surface water diversions and extractions from underground water from two NGWC off-set wells that had been previously found to fall under the SWRCB's jurisdiction as "subterranean streams flowing through known and definite channels". The SWRCB decisions regarding these water extractions are currently under litigation in the Superior Court of Mendocino County. The plaintiff, NGWC, is claiming the water extractions from their off-set wells do not fall under the jurisdiction of the SWRCB.

The Sea Ranch once drew surface water directly from the South Fork Gualala, but they currently draw water from the aquifer below the lower South Fork Gualala riverbed by off-set wells and have augmented storage with an off-site reservoir. The SWRCB again ruled that the water extractions from the aquifer are from "subterranean streams" and are therefore under the SWRCB jurisdiction. The Sea Ranch's appropriative water right permit allows for a maximum extraction of 2.8 cfs, although actual historic maximum diversions have been substantially less. These diversions are also dependent on minimum fish by-pass flows stipulated in the SWRCB permit.

Current low flow constraints in the Gualala River will most likely prohibit future additional appropriative water allocations; however, greater use of the rights allocated to the Sea Ranch is expected in the future.

The NCWQCB's Water Quality Control Plan for the North Coastal Basin (1996) designates ten existing and one potential beneficial uses of water for the Gualala River watershed. The Water Board has responsibility for protecting all beneficial uses. Accordingly, the water quality parameters assessed in this report are compared to water quality objectives for the protection of all beneficial uses. However, the assessment is focussed primarily on the salmonid fishery beneficial uses: COLD (cold freshwater habitat), SPWN (spawning, reproduction, and/or early development), MIGR (migration of aquatic organisms), EST (estuarine habitat), and REC-1 (water contact recreation-fishing). A complete list of beneficial uses is shown in Appendix 9.

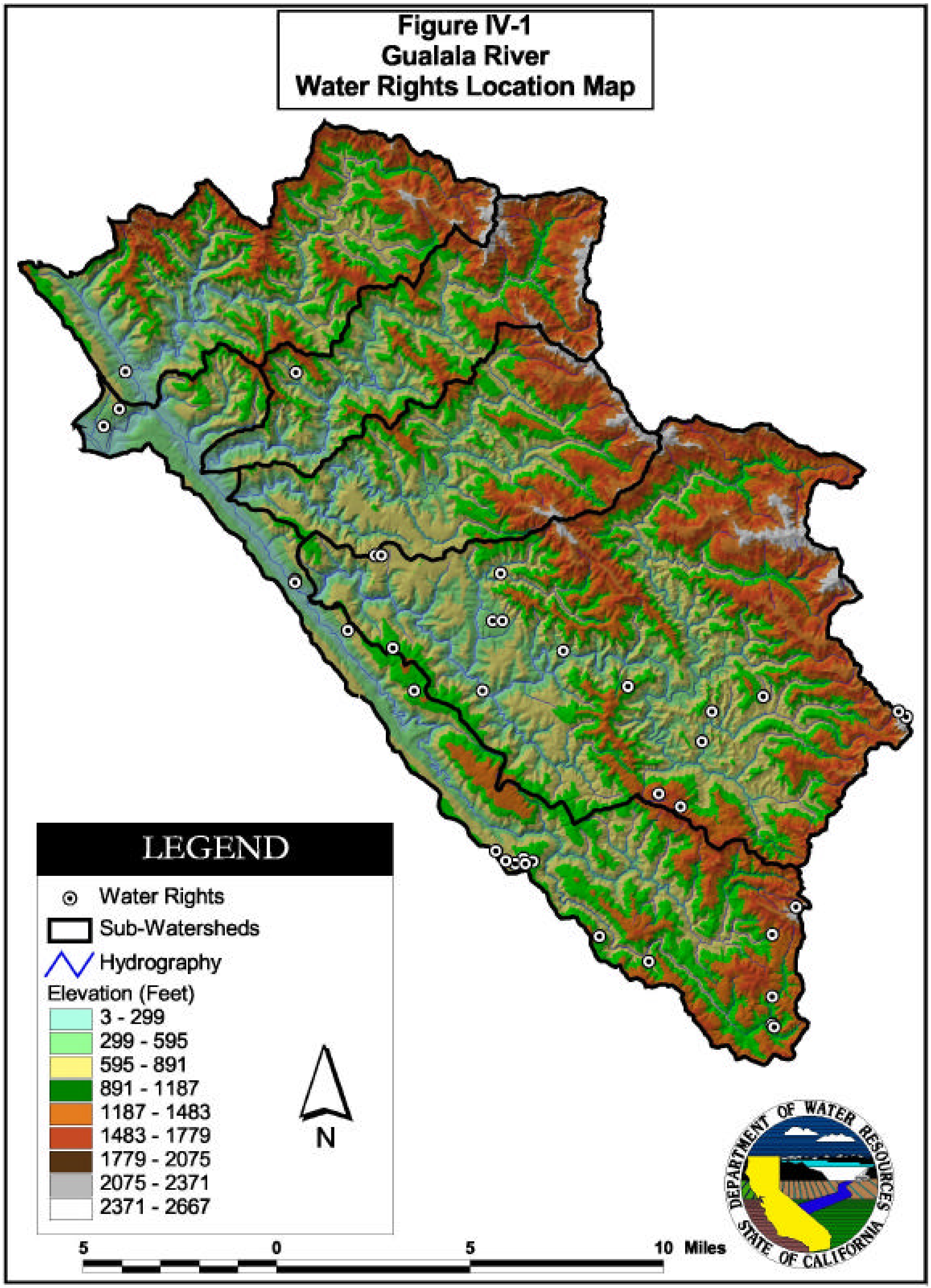


Figure IV-1
Gualala River
Water Rights Location Map
LEGEND
Water Rights
Sub-Watersheds
Hydrography
Elevation (Feet)
3 - 299
299 - 595
595 - 891
891 - 1187
1187 - 1483
1483 - 1779
1779 - 2075
2075 - 2371
2371 - 2667
N
5
0
5
10 Miles
DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA